PATENT ABSTRACTS OF JAPAN

(11)Publication number : 06-147838
(43)Date of publication of application : 27.05.1994

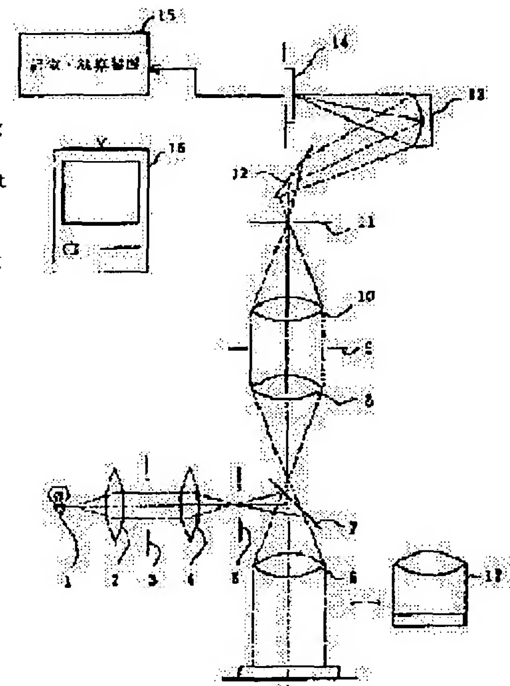
(51)Int.CI. G01B 11/06

(21)Application number : 04-323802
(22)Date of filing : 10.11.1992

(71)Applicant : NIKON CORP
(72)Inventor : ISHII NOBUHITO

(54) FILM THICKNESS MEASURING METHOD

(57)Abstract:
PURPOSE: To allow measurement of microarea by storing a noise output signal to be generated from a light receiving element when a stage for mounting a thin film is blackened and then irradiated with white light thereby canceling optical noise in a film thickness measuring apparatus.
CONSTITUTION: A stage is covered with a black cloth and a white light source 1 is lighted. Light emitted from the light source 1 passes through a lens 2 and an objective lens 6 and impinges on the black cloth which does not reflect the light toward a photoelectric converting element 14. But flare caused by scattering or reflection at respective parts of an optical system constituting a film thickness measuring apparatus passes through a lens 8, a polarizer, and the like and impinges on the element 14 to produce noise output. The noise output signal is measured and stored in a storing/operating unit 15. A thin film is then mounted at a predetermined position on the stage and the light source 1 is lighted. Subsequently, output signal from the element 14 is measured and fed to the unit 15 where the quantity of light is corrected according to measurements previously stored therein thus producing a corrected quantity of light for each wavelength.



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[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]

[Claim 1] In the thickness-measurement method which measures thickness by carrying out the spectrophotometry of the interference reflected light of the white light irradiated by the thin film Where the portion on the stage in which the aforementioned thin film is laid is beforehand made dark, when the aforementioned white light is irradiated, The thickness-measurement method characterized by memorizing the noise output signal which a photo detector generates for the storage means, computing a spectral reflectance by subtracting the aforementioned noise output signal from the measurement output signal which the aforementioned photo detector generates at the time of spectrophotometry, and measuring thickness.

[Claim 2] In the thickness-measurement method which measures thickness by carrying out the spectrophotometry of the interference reflected light of the white light irradiated by the thin film Where the portion on the stage in which the aforementioned thin film is laid is beforehand made dark, when the aforementioned white light is irradiated, Where a quantity of light monitor is installed in the portion on the noise output signal which a photo detector generates, and the stage in which the aforementioned thin film is laid, when the aforementioned white light is irradiated, The ratio with the monitor output signal which a photo detector generates is memorized for the storage means. The thickness-measurement method characterized by computing a spectral reflectance by subtracting the value which multiplied by the monitor output signal which the aforementioned photo detector generates where a quantity of light monitor is installed in the aforementioned position at the time of the aforementioned ratio and measurement from the measurement output signal which the aforementioned photo detector generates, and measuring thickness at the time of spectrophotometry.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the thickness-measurement method which measures the thickness by carrying out the spectrophotometry of the interference light of thin films, such as an oxide film which started the thickness-measurement method, especially was formed on the semiconductor substrate.
[0002]
[Description of the Prior Art] In recent years, semiconductor devices, such as LSI, have been integrated highly remarkably. The degree of integration of this semiconductor device is dependent on the thickness of thin films, such as an oxide film formed by each manufacturing process, and in order to attain high integration, the need of carrying out thickness management of a thin film in a high precision has been increasing increasingly. As the thickness-measurement method of performing this kind of optical thickness measurement, it asks for the spectral reflectance of the thin film used as the measuring object conventionally, extremal value (maximal value or minimal value) is computed from the obtained spectral-reflectance curve, and the method of computing a thickness value is used from the wavelength which obtains the extremal value, and the refractive index.
[0003] This kind of the thickness-measurement method irradiated drawing of a sample side and a conjugate position to the white light at the through sample, and has led the reflected light to the spectroscope through drawing of a sample side and a conjugate position. In measuring a detailed field, it corresponds by extracting drawing by the side of light-receiving.
[0004] Before passing along such optical system, it reflects by the optical surface with a part of various incident rays etc., and noise is made by reaching a detector. In order to decrease noise conventionally, generating of noise was reduced equivalent to drawing by the side of light-receiving of drawing by the side of irradiation, or by enlarging a little and shading the light without regards to measurement.
[0005]
[Problem(s) to be Solved by the Invention] however -- although noise can be reduced by the above-mentioned method, since elimination is completely impossible -- the right spectrum -- there was a trouble that an on-the-strength curve could not be obtained Furthermore, there was a problem that it could not measure while observing the whole surface of a sample, since the field to irradiate is narrow.
[0006] this invention aims at offer of the thickness-measurement method which can measure a minute field, eliminating the noise (FUREA) of the light in thickness-measurement equipment, and observing the whole surface of a sample in view of such a trouble.
[0007]
[Means for Solving the Problem] In the thickness-measurement method which this invention irradiates the white light at the thin film of the measuring object, and carries out the spectrometry of the reflective interference light of a thin film, measures the spectral reflectance in the predetermined wavelength range, and calculates the thickness of a thin film Where the portion on the stage in which a thin film is laid is beforehand made dark, when the white light is irradiated, a measurement output signal to the noise output signal which memorizes the noise output signal which a photo detector generates for the storage means, and a photo detector generates at the time of spectrophotometry -- reducing -- a predetermined spectrum -- it is the thickness-measurement method which computed the light curve
[0008] Moreover, irradiate the white light at the thin film of the measuring object, carry out the spectrometry of the reflective interference light of a thin film, measure the spectral reflectance in the predetermined wavelength range, and it sets to the thickness-measurement method which calculates the thickness of a thin film. Where the portion on the stage in which a thin film is laid is beforehand made dark, when the white light is irradiated, Where a quantity of light monitor is installed in the portion on the noise output signal which a photo detector generates, and the stage in which a thin film is laid, when the white light is irradiated, The ratio with the monitor output signal which a photo detector generates is memorized for the storage means. the value which multiplied by the monitor output signal which a photo detector generates where a quantity of light monitor is installed in a position at the time of a ratio and measurement from the measurement output signal which a photo detector generates at the time of spectrophotometry -- reducing -- a predetermined spectrum -- the thickness-measurement method characterized by computing a light curve is also desirable
[0009]
[Function] Where the portion on the stage in which a thin film is laid is made dark, when the white light is irradiated according to this invention, the noise output signal which a photo detector generates can be measured, and amendment can be added.
[0010] Moreover, when a quantity of light monitor is used and the white light is irradiated in this state, without only reducing the noise output signal which a photo detector generates as it was when the white light is irradiated, where the portion on the stage in which a thin film is laid is made dark, the noise output signal which a photo detector generates can be measured, and amendment can also be added using both ratio.
[0011] In the case of the thickness-measurement equipment which has the function which acts to the interior of thickness-measurement equipment as the monitor of the quantity of light of the light source, and the thickness-measurement equipment which it does not have, it divides, and measurement of each output signal value used for the amendment and amendment by these this inventions is explained. When it does not have a quantity of light monitor, it is in the state which

made dark first the portion on the stage in which this thin film is laid, and the light source is turned on, the noise output signal which rotates a diffraction grating and a photo detector generates over full wave length is measured, and it is Iflare.i about the measured value in this state. It carries out. And this is memorized. Subsequently, a thin film is set as a predetermined position, the measurement output signal which a photo detector receives and is generated is measured, and it is Imeasure.i about the measured value in this state. It carries out. The amended quantity of light Ii which carried out the normal mode rejection It is expressed with the following formula.
Ii =Imeasure .i-Iflare.i .... (formula 1)
[0012] The noise output signal which a photo detector generates where the portion on the stage in which a thin film is beforehand laid like the above-mentioned is made dark when it has a quantity of light monitor is measured, and it is Iflare.i about the measured value in this state. It carries out. Subsequently, a quantity of light monitor is set as the position on the stage in which a thin film is laid, and a photo detector measures the measurement output signal received and generated, and sets measured value in this state to Imonitor0.i. and both ratio -- Iflare.i/Imonitor0.i is calculated and memorized When actually measuring thickness, the direct front stirrup of measurement is set as the position on the stage in which a thin film is laid in a quantity of light monitor immediately after, measures the measurement output signal which a photo detector receives and is generated, and sets measured value in this state to Imonitor1.i. Subsequently, a thin film is set as a predetermined position, the measurement output signal which a photo detector receives and is generated is measured, and it is Imeasure.i about the measured value in this state. It carries out. The amended quantity of light Ii which carried out the normal mode rejection It is expressed with the following formula.
Ii =Imeasure .i-[Iflare.i/Imonitor0.i] and Imonitor1.i .... (formula 2)
[0013]
[Example] One example of the thickness-measurement method concerning this invention is explained with reference to drawing 1 and drawing 2 . drawing 1 -- a spectrum -- a spectrum when it is drawing showing an on-the-strength curve and, as for (a), noise is intermingled from a thin film to the reflected light -- an on-the-strength curve and (b) -- the spectrum of only noise -- the spectrum of the reflected light from an on-the-strength curve and the thin film which (c) amended noise and was removed -- it is an on-the-strength curve Drawing 2 is the system configuration view of one example of the thickness-measurement equipment adapting the thickness-measurement method concerning this invention. On Stage T, the samples S, such as a substrate, are usually laid, and test-section grade is positioned by the position. It is reflected by the one-way mirror 7 arranged on an optical axis through a lens 2, drawing 3, a lens 4, and drawing 5, and the light emitted from the white light source 1 illuminates the sample S laid on Stage T through an objective lens 6. And incidence of the light reflected from the sample side is again carried out to an objective lens 6, it penetrates a one-way mirror 7, and converges it on the entrance slit 11 formed in the light sensing portion of a spectroscope through a lens 8, drawing 9, and a lens 10. It reflects by the mirror M2, and incidence of the light which passed the entrance slit 11 is carried out to a diffraction grating 13, the spectrum of it is carried out and it carries out incidence to an optoelectric transducer 14. This optoelectric transducer 14 is CCD, photo electric translation is performed, and the electrical signal corresponding to optical predetermined intensity distribution is outputted. An electrical signal displays a thickness value on display 16 after an operation with storage and an arithmetic unit 15.
[0014] Next, operation which adds amendment to the measurement when not having a quantity of light monitor with such thickness-measurement equipment is explained. It covers with the black cloth which absorbs light and does not reflect Stage T, and the white light source 1 is turned on. Although incidence of the light emitted from the white light source 1 is carried out to a lens 2 and it irradiates black cloth through an objective lens 6, since it is absorbed with black cloth and does not reflect, incidence of it is again carried out to an objective lens 6, and it does not carry out incidence to an optoelectric transducer 14 through a lens 8, a spectroscope, etc. However, in each portion of the optical system which constitutes thickness-measurement equipment, there is flare light by dispersion or reflection, this carries out incidence to a lens 8, incidence is carried out to an optoelectric transducer 14 through a spectroscope etc., and a noise output occurs. The noise output signal which rotates the diffraction grating 13 of a spectroscope and an optoelectric transducer 14 generates over full wave length is measured, and it is Iflare.i about this measured value. It considers as correction value, inputs into storage and an arithmetic unit 15, and memorizes.
[0015] Subsequently, a thin film S is laid in the predetermined position on Stage T, the white light source 1 is turned on, the output signal which an optoelectric transducer 14 generates over full wave length similarly is measured, and it is measured-value Imeasure.i. It inputs into storage and an arithmetic unit 15. Quantity of light Ii Measured-value Iflare.i which has memorized measured-value Imeasure.i to storage and the arithmetic unit 15 previously It amends and is computed for every wavelength according to a formula 1.
Ii =Imeasure .i-Iflare.i .... (formula 1)
the spectrum with which the thickness value is beforehand memorized to storage and the arithmetic unit 15 -- the well-known formula which asks for thickness from an on-the-strength curve -- following -- the quantity of light Ii of each wavelength By substituting, it is computed and is displayed on display 16. measured-value Imeasure.i a spectrum when noise is intermingled from the thin film shown in drawing 1 (a) to the reflected light -- an on-the-strength curve -- corresponding -- measured-value Iflare.i the spectrum of only the noise shown in drawing 1 (b) -- the spectrum of the reflected light from the thin film which amended and removed the noise shown for corresponding to an on-the-strength curve -- it corresponds to the on-the-strength curve
[0016] The temperature of the environment where the size of a noise output changed with temperature, humidity, etc., and equipment was placed, humidity, etc. change with time. For this reason, since correction value changes with time, it is Iflare.i for every thickness measurement. Measuring is desirable.
[0017] Next, operation which adds amendment to the measurement in the case of having a quantity of light monitor with such thickness-measurement equipment is explained. The quantity of light monitor unit 17 shown in drawing 2 can be interexchangeably attached in the main part of thickness-measurement equipment with an objective lens 6, and has become lens 17a from mirror 17b under it. The noise output signal in which light is covered with the black cloth which is not absorbed and reflected, and an optoelectric transducer 14 generates Stage T over full wave length is measured like the time of not having a quantity of light monitor probably, and it is Iflare.i about this measured value. It inputs into storage and an arithmetic unit 15, and memorizes.
[0018] Subsequently, an objective lens 6 is demounted, it exchanges for the quantity of light monitor unit 17, and the white light source 1 is turned on. Incidence of the light emitted from the white light source 1 is carried out to a lens 2, in mirror

17b, it reflects through lens 17a, and incidence of it is again carried out to lens 17a, and it carries out incidence to an optoelectric transducer 14 through a lens 8, a spectroscope, etc. The output signal which an optoelectric transducer 14 generates over full wave length is measured, and measured-value Imonitor0.i is inputted into storage and an arithmetic unit 15. And both ratio Iflare.i/Imonitor0.i It calculates and memorizes with storage and the arithmetic unit 15.

[0019] When actually measuring the thickness of a thin film S, in advance of the measurement, an output signal is measured using the quantity of light monitor unit 17, and measured-value Imonitor1.i is inputted into storage and an arithmetic unit 15, and is memorized.

[0020] Subsequently, a thin film S is laid in the predetermined position on Stage T, the white light source 1 is turned on, the output signal which an optoelectric transducer 14 generates over full wave length similarly is measured, and it is measured-value Imeasure.i. It inputs into storage and an arithmetic unit 15. Quantity of light Ii Measured-value Imeasure.i Ratio which uses measured-value Imonitor1.i measured in advance of measurement using the quantity of light monitor unit 17, and asks for beforehand and which has been memorized to storage and the arithmetic unit 15 Iflare.i/Imonitor0.i It amends and is computed for every wavelength according to a formula 2.

Ii =Imeasure .i-[Iflare.i/Imonitor0.i] and Imonitor1.i .... (formula 2)

the spectrum with which the thickness value is beforehand memorized to storage and the arithmetic unit 15 -- the well-known formula which asks for thickness from an on-the-strength curve -- following -- the quantity of light Ii of each wavelength By substituting, it is computed and is displayed on display 16.

[0021] The temperature of the environment where the size of a noise output changed with temperature, humidity, etc., and equipment was placed, humidity, etc. change with time. However, ratio Since Iflare.i/Imonitor0.i is the ratio of the measured value of the period, its change by environmental influence is small. moreover, the black cloth which absorbs light and does not reflect Stage T -- covering -- Iflare.i using an objective lens 6 and the quantity of light monitor unit 17 which can carry out compatibility easily, although measuring must prepare black cloth each time -- rather -- ** -- it is not troublesome

[0022] In order to decrease noise according to this example, it extracts as the drawing 3 by the side of irradiation, and it can enlarge a little, and it is unnecessary that it is [of shading the light without regards to measurement] equivalent to the drawing 9 by the side of light-receiving of 5, and it can set up the size of each drawing according to the object of measurement. When measuring a detailed field, it is unnecessary to extract drawing by the side of light-receiving.

[0023]

[Effect of the Invention] While the noise (FUREA) of the light in thickness-measurement equipment is eliminated and the whole surface of a sample observes by this invention, measurement of a minute field is attained.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] a spectrum when, as for (a), noise is intermingled from a thin film to the reflected light -- it is an on-the-strength curvilinear **** view (b) -- the spectrum of only noise -- it is drawing showing an on-the-strength curve the spectrum of the reflected light from the thin film which (c) amended noise and was removed -- it is drawing showing an on-the-strength curve
[Drawing 2] It is the system chart of the thickness-measurement equipment which applied this invention.
[Description of Notations in the Main Part]
1 ... White light source
2 ... Lens
3 ... Drawing
4 ... Lens
5 ... Drawing
6 ... Objective lens
7 ... One-way mirror
8 ... Lens
9 ... Drawing
10 ... Lens
11 ... Drawing
12 ... Reflective mirror
13 ... Spectroscope
14 ... Detector
15 ... Storage and arithmetic unit
16 ... Display

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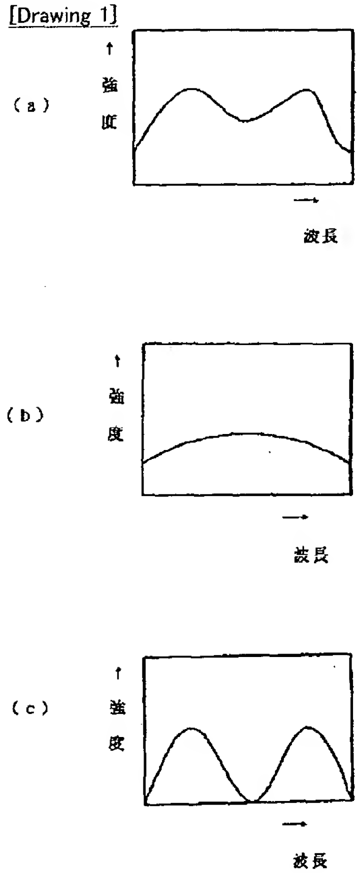
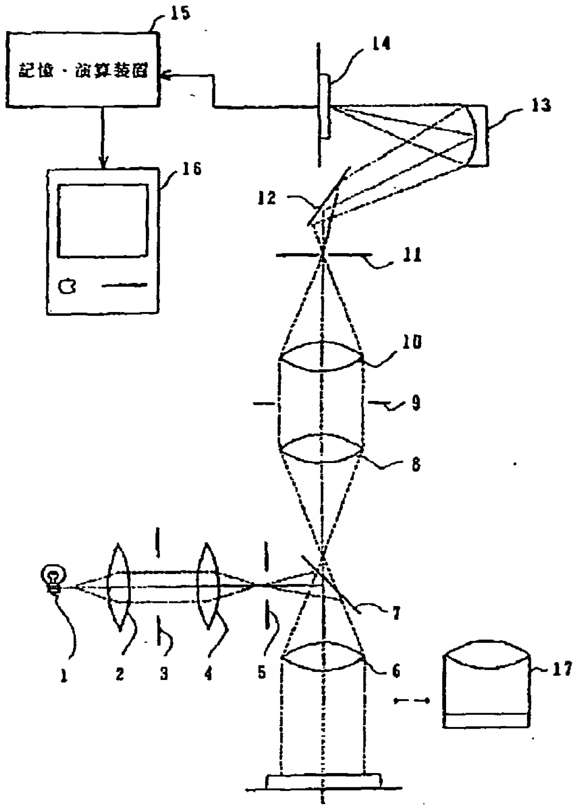
DRAWINGS

[Drawing 1]



[Drawing 2]



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(19)日本国特許庁（JP）　(12) **公開特許公報**（A）　(11)特許出願公開番号

特開平6−147838

(43)公開日　平成6年(1994)5月27日

(51)Int.Cl.^{5}	識別記号	庁内整理番号	FI	技術表示箇所
G01B 11/06	G	8708−2F		

審査請求　未請求　請求項の数2(全 5 頁)

(21)出願番号　特願平4−323802

(22)出願日　平成4年(1992)11月10日

(71)出願人　000004112
株式会社ニコン
東京都千代田区丸の内3丁目2番3号

(72)発明者　石井　信人
東京都千代田区丸の内3丁目2番3号　株式会社ニコン内

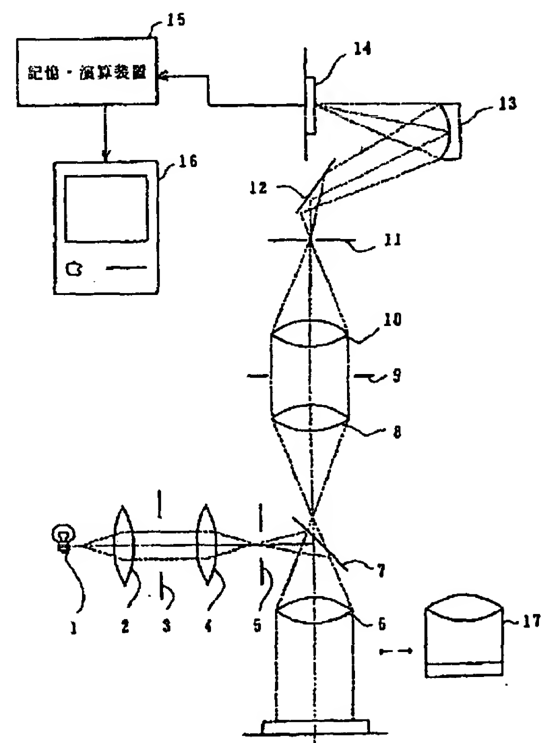
(74)代理人　弁理士　市村　健夫

(54)【発明の名称】　膜厚測定方法

(57)【要約】

【目的】　光の雑音を消去し、かつ試料の全面の観察をしながらの微小領域の膜厚測定方法を提供することである。

【構成】　あらかじめ、薄膜が載置されるステージ上の部分を暗黒にした状態で白色光を照射したとき、受光素子が発生する雑音出力信号を記憶手段に記憶しておき、分光測光時に、受光素子が発生する測定出力信号から雑音出力信号を減じて所定の分光光度曲線を算出する。光量モニターを使用することもできる。



【特許請求の範囲】
【請求項1】　薄膜に照射された白色光の干渉反射光を分光測光することにより、膜厚を測定する膜厚測定方法において、
あらかじめ、前記薄膜が載置されるステージ上の部分を暗黒にした状態で前記白色光を照射したとき、受光素子が発生する雑音出力信号を記憶手段に記憶しておき、
分光測光時に、前記受光素子が発生する測定出力信号から前記雑音出力信号を減じて分光反射率を算出し、膜厚を測定することを特徴とする膜厚測定方法。
【請求項2】　薄膜に照射された白色光の干渉反射光を分光測光することにより、膜厚を測定する膜厚測定方法において、
あらかじめ、前記薄膜が載置されるステージ上の部分を暗黒にした状態で前記白色光を照射したとき、受光素子が発生する雑音出力信号と、前記薄膜が載置されるステージ上の部分に光量モニターを設置した状態で前記白色光を照射したとき、受光素子が発生するモニター出力信号との比を記憶手段に記憶しておき、
分光測光時に、前記受光素子が発生する測定出力信号から、前記比と測定時に光量モニターを前記位置に設置した状態で前記受光素子が発生するモニター出力信号を乗じた値を減じて分光反射率を算出し、膜厚を測定することを特徴とする膜厚測定方法。
【発明の詳細な説明】
【0001】
【産業上の利用分野】本発明は、膜厚測定方法に係り、特に半導体基板上に形成された酸化膜等の薄膜の干渉光を分光測光することによりその膜厚を測定する膜厚測定方法に関する。
【0002】
【従来の技術】近年、ＬＳＩ等の半導体デバイスは著しく高集積化されてきている。この半導体デバイスの集積度は、各製造工程で形成される酸化膜等の薄膜の膜厚に依存しており、高集積化を図るためには高い精度で薄膜の膜厚管理をする必要性がますます高まってきている。従来、この種の光学的膜厚測定を行う膜厚測定方法としては、測定対象となる薄膜の分光反射率を求め、得られた分光反射率曲線から極値（極大値あるいは極小値）を算出し、その極値を得る波長、屈折率から膜厚値を算出する方法が使用されている。
【0003】この種の膜厚測定方法は、白色光を試料面と共役な位置の絞りを通し試料に照射し、反射光を試料面と共役な位置の絞りを通して分光器へと導いている。微細な領域を測定する場合には、受光側の絞りを絞ることで対応している。
【0004】これらの光学系を通る前に、入射光線の一部が様々な光学面などで反射し、検知器に到達することにより雑音が生じる。従来は、雑音を減少させるために照射側の絞りを受光側の絞りと同等もしくは若干大きくし測定に関わらない光を遮光することにより、雑音の発生を低減させていた。
【0005】
【発明が解決しようとする課題】ところが、上記の方式では雑音を低減できるが、完全には消去はできないから正しい分光強度曲線を得ることができないという問題点があった。さらに、照射する領域が狭いので試料の全面を観察しながら測定することができないという問題があった。
【0006】本発明はこのような問題点に鑑み、膜厚測定装置内の光の雑音（フレア）を消去し、かつ試料の全面の観察をしながら微小領域の測定が可能な膜厚測定方法の提供を目的とする。
【0007】
【課題を解決するための手段】本発明は、測定対象の薄膜に白色光を照射し、薄膜の反射干渉光を分光測定してその分光反射率を所定の波長範囲で測定し、薄膜の膜厚を算定する膜厚測定方法において、あらかじめ、薄膜が載置されるステージ上の部分を暗黒にした状態で白色光を照射したとき、受光素子が発生する雑音出力信号を記憶手段に記憶しておき、分光測光時に、受光素子が発生する測定出力信号から雑音出力信号を減じて所定の分光光度曲線を算出するようにした膜厚測定方法である。
【0008】又、測定対象の薄膜に白色光を照射し、薄膜の反射干渉光を分光測定してその分光反射率を所定の波長範囲で測定し、薄膜の膜厚を算定する膜厚測定方法において、あらかじめ、薄膜が載置されるステージ上の部分を暗黒にした状態で白色光を照射したとき、受光素子が発生する雑音出力信号と、薄膜が載置されるステージ上の部分に光量モニターを設置した状態で白色光を照射したとき、受光素子が発生するモニター出力信号との比を記憶手段に記憶しておき、分光測光時に、受光素子が発生する測定出力信号から、比と測定時に光量モニターを位置に設置した状態で受光素子が発生するモニター出力信号を乗じた値を減じて、所定の分光光度曲線を算出することを特徴とする膜厚測定方法も望ましいものである。
【0009】
【作用】本発明によれば、薄膜が載置されるステージ上の部分を暗黒にした状態で白色光を照射したとき、受光素子が発生する雑音出力信号を測定して補正を加えることができる。
【0010】又薄膜が載置されるステージ上の部分を暗黒にした状態で白色光を照射したとき、受光素子が発生する雑音出力信号をそのまま単に減ずることなく、光量モニタを使用し、この状態で白色光を照射したとき受光素子が発生する雑音出力信号を測定し、両者の比を使用して補正を加えることもできる。
【0011】これらの本発明による補正及び補正に使用される各出力信号値の測定について、膜厚測定装置内部

に光源の光量をモニターする機能を有する膜厚測定装置と、有しない膜厚測定装置の場合に分けて説明する。光量モニターを有しない場合は先ず、この薄膜が載置されるステージ上の部分を暗黒にした状態で、光源を点灯し、回折格子を回転して全波長にわたって受光素子が発生する雑音出力信号を測定し、この状態での測定値を $I_{flare.i}$ とする。そしてこれを記憶しておく。次いで薄膜を所定位置に設定し受光素子が受光し発生する測定出力信号を測定し、この状態での測定値を $I_{measure.i}$ とする。雑音除去し補正した光量 I_i は次式で表される。

$$I_i = I_{measure.i} - I_{flare.i} \quad \ldots\ldots \text{（式１）}$$

【００１２】光量モニターを有する場合、あらかじめ前述と同様に薄膜が載置されるステージ上の部分を暗黒にした状態で、受光素子が発生する雑音出力信号を測定し、この状態での測定値を $I_{flare.i}$ とする。次いで光量モニターを薄膜が載置されるステージ上の位置に設定し受光素子が受光し発生する測定出力信号を測定し、この状態での測定値を $I_{monitor0.i}$ とする。そして両者の比

$I_{flare.i} / I_{monitor0.i}$

を計算し記憶しておく。実際に膜厚を測定する時は、測定の直前又は直後に光量モニターを薄膜が載置されるステージ上の位置に設定し受光素子が受光し発生する測定出力信号を測定し、この状態での測定値を $I_{monitor1.i}$ とする。次いで薄膜を所定位置に設定し受光素子が受光し発生する測定出力信号を測定し、この状態での測定値を $I_{measure.i}$ とする。雑音除去し補正した光量 I_i は次式で表される。

$$I_i = I_{measure.i} - \left(I_{flare.i} / I_{monitor0.i} \right) \cdot I_{monitor1.i} \quad \ldots\ldots \text{（式２）}$$

【００１３】

【実施例】本発明にかかる膜厚測定方法の一実施例を図１及び図２を参照して説明する。図１は分光強度曲線を示す図であり、（ａ）は薄膜からの反射光に雑音が混在したときの分光強度曲線、（ｂ）は雑音のみの分光強度曲線、（ｃ）は雑音を補正して除去した薄膜からの反射光の分光強度曲線である。図２は、本発明にかかる膜厚測定方法を応用した膜厚測定装置の一実施例のシステム構成図である。ステージＴの上には通常は基板等の試料Ｓが載置され、測定部位が所定の位置に位置決めされるようになっている。白色光源１から放射された光はレンズ２、絞り３、レンズ４及び絞り５を介し、光軸上に配置されたハーフミラー７で反射され、ステージＴ上に載置された試料Ｓを対物レンズ６を介して照明する。そして試料面から反射した光は再び対物レンズ６に入射し、ハーフミラー７を透過して、レンズ８、絞り９及びレンズ１０を介して、分光器の受光部に形成された入射スリット１１に収束する。入射スリット１１を通過した光はミラーＭ２で反射して回折格子１３に入射し、分光されて光電変換素子１４に入射する。この光電変換素子１４はＣＣＤであり光電変換が行われて、所定の光強度分布に対応した電気信号が出力される。電気信号は記憶・演算装置１５により演算後、膜厚値を表示装置１６上に表示するようになっている。

【００１４】次にこのような膜厚測定装置で、光量モニターを有しない場合の測定に補正を加える動作について説明する。ステージＴを光を吸収し反射しない黒い布で覆い、白色光源１を点灯する。白色光源１から放射された光はレンズ２に入射し、対物レンズ６を介し黒い布を照射するが、黒い布で吸収されて反射しないから対物レンズ６に再度入射しレンズ８、分光器等を介して光電変換素子１４に入射することはない。しかし膜厚測定装置を構成する光学系の各部分では散乱や反射によるフレアー光があって、これがレンズ８に入射し、分光器等を介して光電変換素子１４に入射し、雑音出力が発生する。分光器の回折格子１３を回転して全波長にわたって光電変換素子１４が発生する雑音出力信号を測定し、この測定値を $I_{flare.i}$ を補正値として記憶・演算装置１５に入力し、記憶する。

【００１５】次いで薄膜Ｓをステージ T 上の所定位置に載置し、白色光源１を点灯して、同様に全波長にわたって光電変換素子１４が発生する出力信号を測定し、測定値 $I_{measure.i}$ を記憶・演算装置１５に入力する。光量 I_i は、測定値 $I_{measure.i}$ を先に記憶・演算装置１５に記憶してある測定値 $I_{flare.i}$ により補正して、式１に従って各波長ごとに算出される。

$$I_i = I_{measure.i} - I_{flare.i} \quad \ldots\ldots \text{（式１）}$$

膜厚値はあらかじめ記憶・演算装置１５に記憶してある分光強度曲線から膜厚を求める公知の計算式に従い、各波長の光量 I_i を代入することにより算出され、表示装置１６上に表示される。測定値 $I_{measure.i}$ は図１（ａ）に示す薄膜からの反射光に雑音が混在したときの分光強度曲線に対応し、測定値 $I_{flare.i}$ は図１（ｂ）に示す雑音のみの分光強度曲線に対応し、に示す雑音を補正して除去した薄膜からの反射光の分光強度曲線に対応している。

【００１６】雑音出力の大きさは温度、湿度等によって変化し、また装置の置かれた環境の温度、湿度等も時間とともに変化する。このため補正値が時間とともに変化するから、膜厚測定ごとに $I_{flare.i}$ を測定するのが望ましい。

【００１７】次にこのような膜厚測定装置で、光量モニターを有する場合の測定に補正を加える動作について説明する。図２に示す光量モニターユニット１７は対物レンズ６と互換的に膜厚測定装置の本体に取付け可能で、

レンズ17aとその下に鏡17bとからなっている。先ず光量モニターを有しないときと同様に、ステージTを光を吸収し反射しない黒い布で覆って、全波長にわたって光電変換素子14が発生する雑音出力信号を測定し、この測定値を$I_{flare.i}$を記憶・演算装置15に入力し、記憶する。

【0018】次いで対物レンズ6を取外し光量モニターユニット17と交換し、白色光源1を点灯する。白色光源1から放射された光はレンズ2に入射し、レンズ17aを介し鏡17bにおいて反射し、レンズ17aに再度入射しレンズ8、分光器等を介して光電変換素子14に入射する。全波長にわたって光電変換素子14が発生する出力信号を測定し、測定値$I_{monitor0.i}$を記憶・演算装置15に入力する。そして両者の比　$I_{flare.i}/I_{monitor0.i}$　を記憶・演算装置15で計算し記憶しておく。

【0019】実際に薄膜Sの膜厚を測定する時には、その測定に先立って光量モニターユニット17を使用して出力信号を測定し、測定値$I_{monitor1.i}$を記憶・演算装置15に入力し、記憶する。

【0020】次いで薄膜SをステージT上の所定位置に載置し、白色光源1を点灯して、同様に全波長にわたって光電変換素子14が発生する出力信号を測定し、測定値$I_{measure.i}$を記憶・演算装置15に入力する。光量I_iは、測定値$I_{measure.i}$と測定に先立って光量モニターユニット17を使用して測定した測定値$I_{monitor1.i}$を使用し、あらかじめ求めて記憶・演算装置15に記憶してある比　$I_{flare.i}/I_{monitor0.i}$　により補正して、式2に従って各波長ごとに算出される。

$$I_i = I_{measure.i} - \left[I_{flare.i} / I_{monitor0.i} \right] \cdot I_{monitor1.i} \quad \ldots\ldots (式2)$$

膜厚値はあらかじめ記憶・演算装置15に記憶してある分光強度曲線から膜厚を求める公知の計算式に従い、各波長の光量I_iを代入することにより算出され、表示装置16上に表示される。

【0021】雑音出力の大きさは温度、湿度等によって変化し、また装置の置かれた環境の温度、湿度等も時間とともに変化する。しかし比　$I_{flare.i}/I_{monitor0.i}$は同時期の測定値の比であるために、環境の影響による変化が小さい。又ステージTを光を吸収し反射しない黒い布で覆って、$I_{flare.i}$を測定するのはその都度黒い布を準備しなければならないが、対物レンズ6と容易に互換できる光量モニターユニット17を使用するのは些かも煩わしくない。

【0022】本実施例によると雑音を減少させるために照射側の絞り3と絞り5を受光側の絞り9と同等もしくは若干大きくし測定に関わらない光を遮光するというようなことは必要なく、測定の対象に合わせてそれぞれの絞りの大きさを設定することができる。微細な領域を測定する場合にも、受光側の絞りを絞ることは不必要である。

【0023】

【発明の効果】本発明により、膜厚測定装置内の光の雑音（フレァ）を消去し、かつ試料の全面の観察しながら微小領域の測定が可能となる。

【図面の簡単な説明】

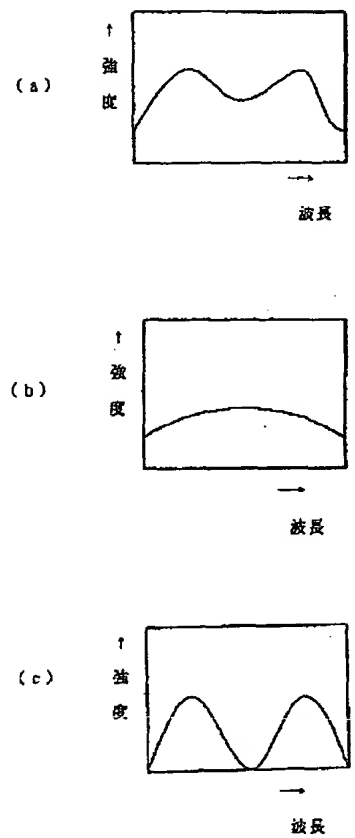
【図1】（a）は薄膜からの反射光に雑音が混在したときの分光強度曲線示す図である。（b）は雑音のみの分光強度曲線を示す図である。（c）は雑音を補正して除去した薄膜からの反射光の分光強度曲線を示す図である。

【図2】本発明を適用した膜厚測定装置のシステム図である。

【主要部分の符号の説明】

1・・・白色光源
2・・・レンズ
3・・・絞り
4・・・レンズ
5・・・絞り
6・・・対物レンズ
7・・・ハーフミラー
8・・・レンズ
9・・・絞り
10・・・レンズ
11・・・絞り
12・・・反射ミラー
13・・・分光器
14・・・検出器
15・・・記憶・演算装置
16・・・表示装置

【図1】



【図2】